

MEMORANDUM

DATE: 9 December, 1996

TO: Pat Gochmour, Gochmour & Associates
Tom Munsen, State of Utah, Division of Oil, Gas and Mining

FROM: Troy Thompson, **HYDRO-TRIAD, LTD**

SUBJECT: Lisbon Valley
HTL Project #: 475-004

This memorandum addresses hydraulic design details for the sediment pond systems and the diversion ditches around the Sentinel Pit 1 at Lisbon Valley. Sediment control systems were designed to reduce the amount of suspended solids that are carried by runoff originating from the waste rock dumps. The diversions ditch systems were designed to safely convey surface water away from the site.

Sediment Ponds and Control

Sediment control will be required as the silty-sand/sandy silt soils will be susceptible to transport during periods of surface runoff (Kinori, 1977). Runoff from the waste rock dump areas were routed through diversion ditches into sediment ponds as shown on the general layout map of the site. Design of the sediment ponds allows for the sediment to be removed from the runoff so that the runoff can be released to the natural downstream waterways. Turbidity levels of the released water will be greatly reduced during the settling process. Sediment ponds were sized according to the following criteria:

- Design storm: 10-year, 24-hour event stored in live storage.
- Live storage: From the invert of the outlet to the top of the straw bale.
- Dead storage: Below elevation of the outlet invert for sediment storage.
- Release structure: Permeable straw bale outlet.
- Length to width: 4 to 1 to prevent short circuiting.
- Pond depth: Mean basin depth of 1.5 to 6 feet.

- Maintenance accessibility: Sediment disposal area accessible to excavators.

The volume of water collected from disturbed areas of the waste rock dump were estimated when determining the required capacity of the sediment ponds. It was assumed 25% of each waste rock dump will be worked at a time and that temporary diversion ditches are constructed such that runoff from the unworked areas bypasses the sediment basins. Runoff from the worked area of the waste rock dumps resulting from the 10-year, 24-hour event are estimated at 50% of the total precipitation. Based upon these assumptions and the design criteria, the following capacities are required at each of the three sediment ponds:

Southwest of Sentinel Pit 2:	900 cubic yards
South of Pad:	1350 cubic yards
East of GTO Pit:	3600 cubic yards

The location of the ponds are illustrated on the Figure 1. Sediment pond layouts at the three areas should be designed according to the criteria listed above. In cases where the length to width ratio of 4 to 1 is unobtainable due to spatial constraints, baffles may be incorporated into the design to achieve a flow length to pond width ratio of 4 to 1. A schematic of the required facilities is shown on Figure 2.

Water will be impounded in the sediment ponds following runoff events. Following each event, water will be slowly released through the straw bale outlets, providing storage for the next event. Flow through the stream bale outlet will be supplemented by pumping if necessary. Sediment storage will be provided below the bottom of the outlet.

Released storm water will be reintroduced into the existing dry washes following removal of sediment.

Diversion Ditch Detail - Sentinel Pit

Natural drainage paths within the mine concession cross area of the proposed Sentinel Pit 1. The diversion system was designed to convey surface water around the west side of the Sentinel Pit. The ditch will be armored to prevent migration of the flow path. Materials used in the construction of the ditch will limit infiltration into the ground and thereby minimize the groundwater discharge to the pit.

Ditch cross sections at three locations in the vicinity of the Sentinel Pit 1 are presented on Figures 3-5. The location of the cross sections are shown on Figure 1. Water surface profiles were generated using the computer program

HEC-RAS, developed by the Army Corps of Engineers. The reader is referred to the Hydro-Triad, Ltd. report, "Lisbon Valley Copper Project - Additional Hydrology Detail" (Hydro-Triad, Ltd., 1996) for details of hydrological and hydraulic techniques used to develop the design flow rates. Backwater effects created by the confluence of the drainage ditches were determined. Ditches were sized to insure design flows will not exceed the capacity of the ditch.

In order to alleviate State of Utah, Division of Oil, Gas and Mining's concerns, the length of ditch along the Sentinel Pit 1 will be armored with VL sized riprap or excavated to bedrock (Hydro-Triad, Ltd., 1996). Both options insure that the channel will be stable against erosion. This stability will prevent flows from migrating back to pre-mining alignments.

The ditch will be constructed at a minimum of 25 feet from the limits of the pit. This distance will allow room for maintenance equipment to maneuver between the ditch and the pit in the event maintenance is required.

Seepage from the ditch into the pit is not expected to be a major concern in the design. Factors which limit the concerns over infiltration include:

- Geotechnical investigations of the in-situ soils indicate permeabilities are low - on the order of 2×10^{-7} cm/s (Welsh et al., 1996).
- Diversion ditches will only carry flows during and immediately after rainfall events. During a majority of the time, ditches will remain dry.
- The quantity of infiltration into the pit generated from the diversion ditches is anticipated to be significantly less than the quantity of direct rainfall on the pit.

If during excavation of the diversion ditches, a permeable layer (sand lens or fractured zone) is encountered, additional action will be taken to reduce the potential for seepage. In these situations, a one foot thick layer of impermeable soil will be installed between the ground and the riprap filter material.

Attachments:

Reference List

Figure 1 - Diversion System Arrangement

Figure 2 - Sediment Pond Schematic

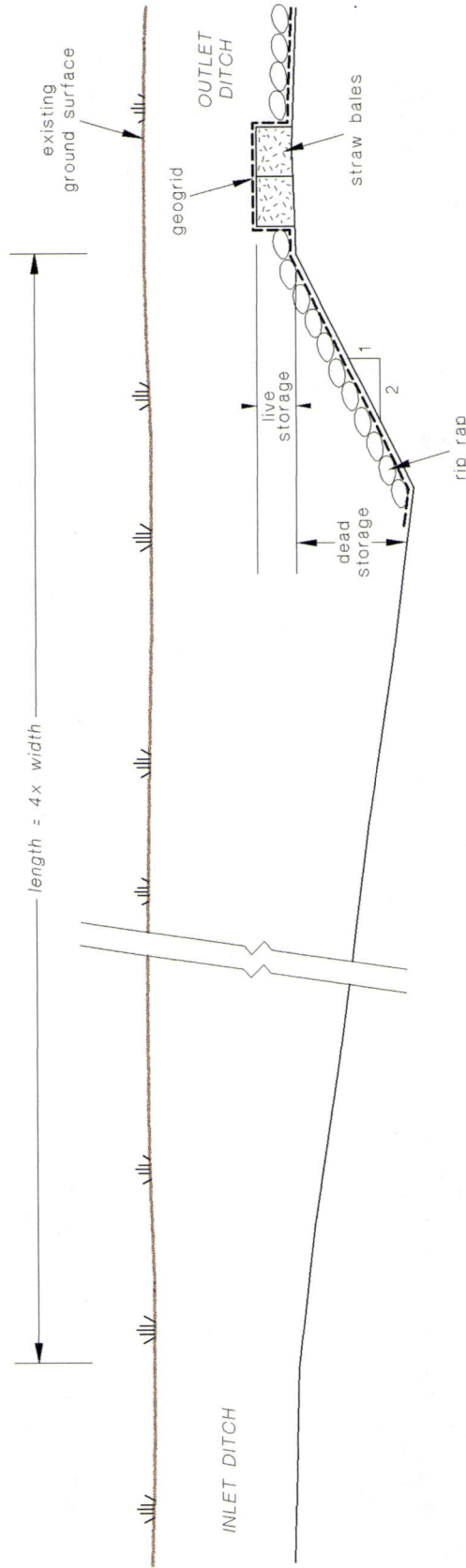
Figure 3 - Diversion Ditch Schematic, Cross Section A-A

Figure 4 - Diversion Ditch Schematic, Cross Section B-B

Figure 5 - Diversion Ditch Schematic, Cross Section C-C

Reference List

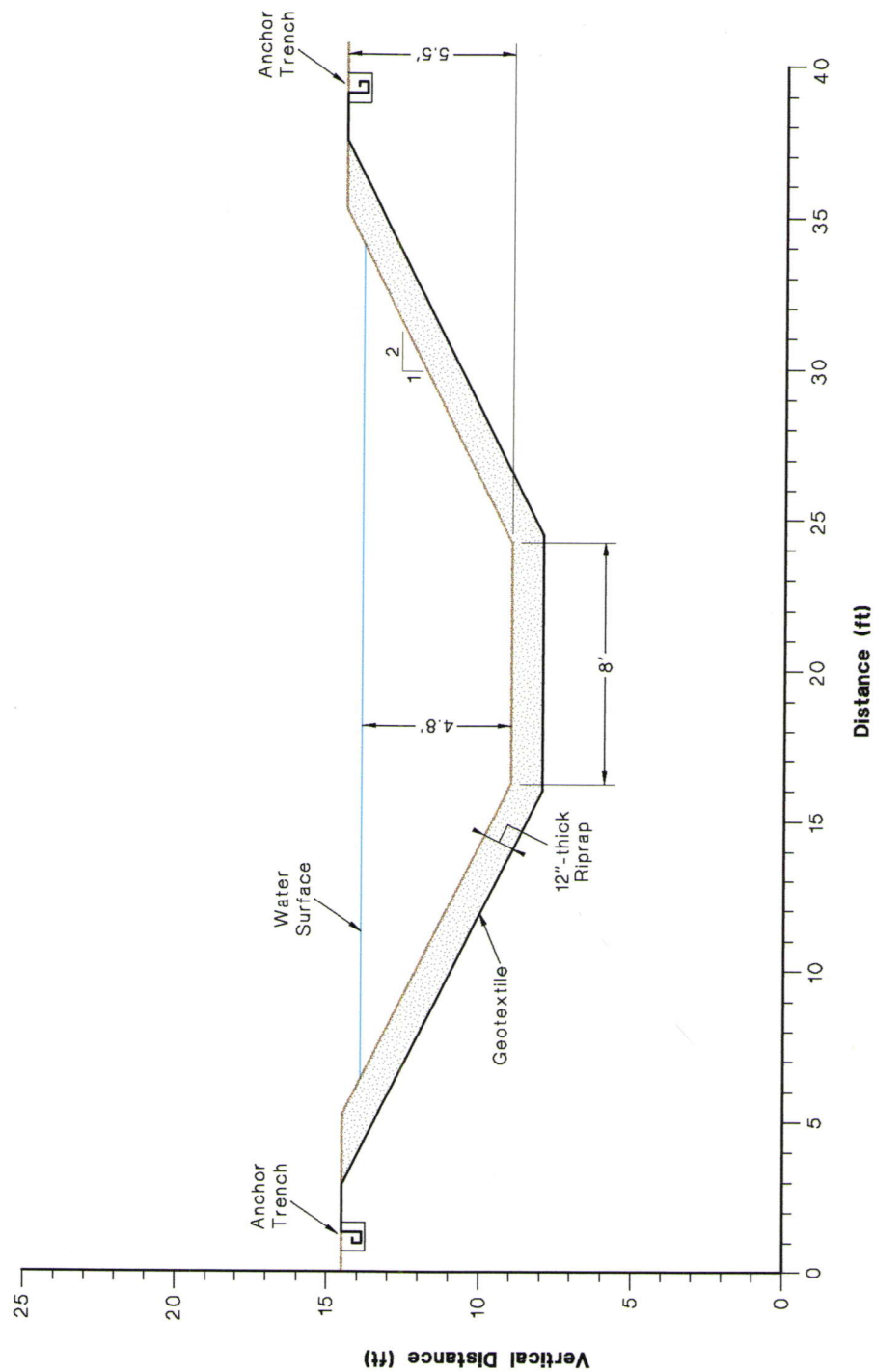
1. Hydro-Triad, Ltd., *Lisbon Valley Copper Project - Additional Hydrology Detail*, 1996.
2. J. D. Welsh & Associates, et al., *Lisbon Valley Project, Heap Leach Facility, Design Report*, 1996.
3. Kinori, B.Z., *Manual of Surface Drainage Engineering, Volume I*, Elsevier Publishing Company, 1977.



Sediment Pond Schematic

December 1996

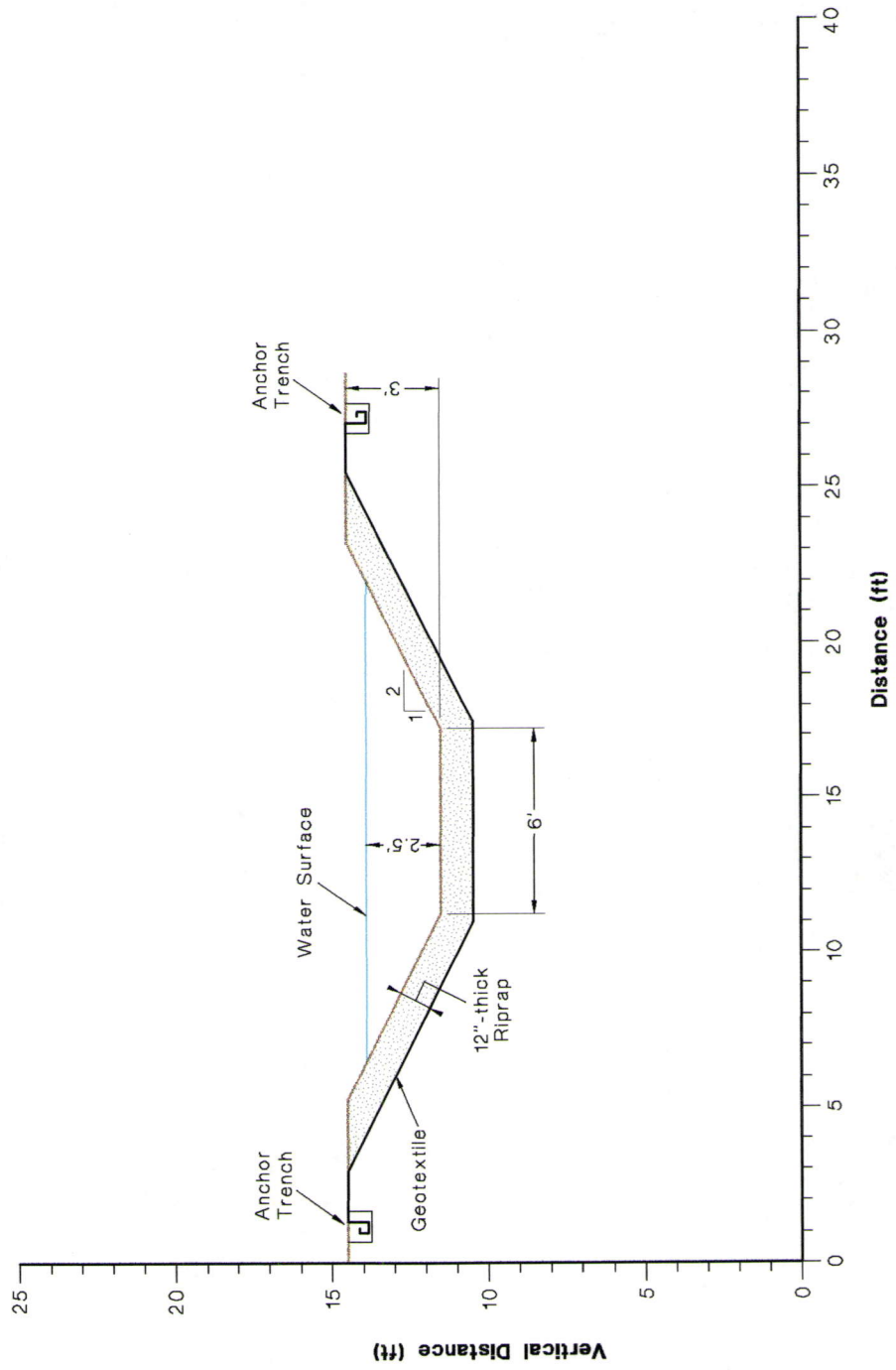
Figure 2



Diversion Ditch Schematic Cross Section A-A

December 1996

Figure 3

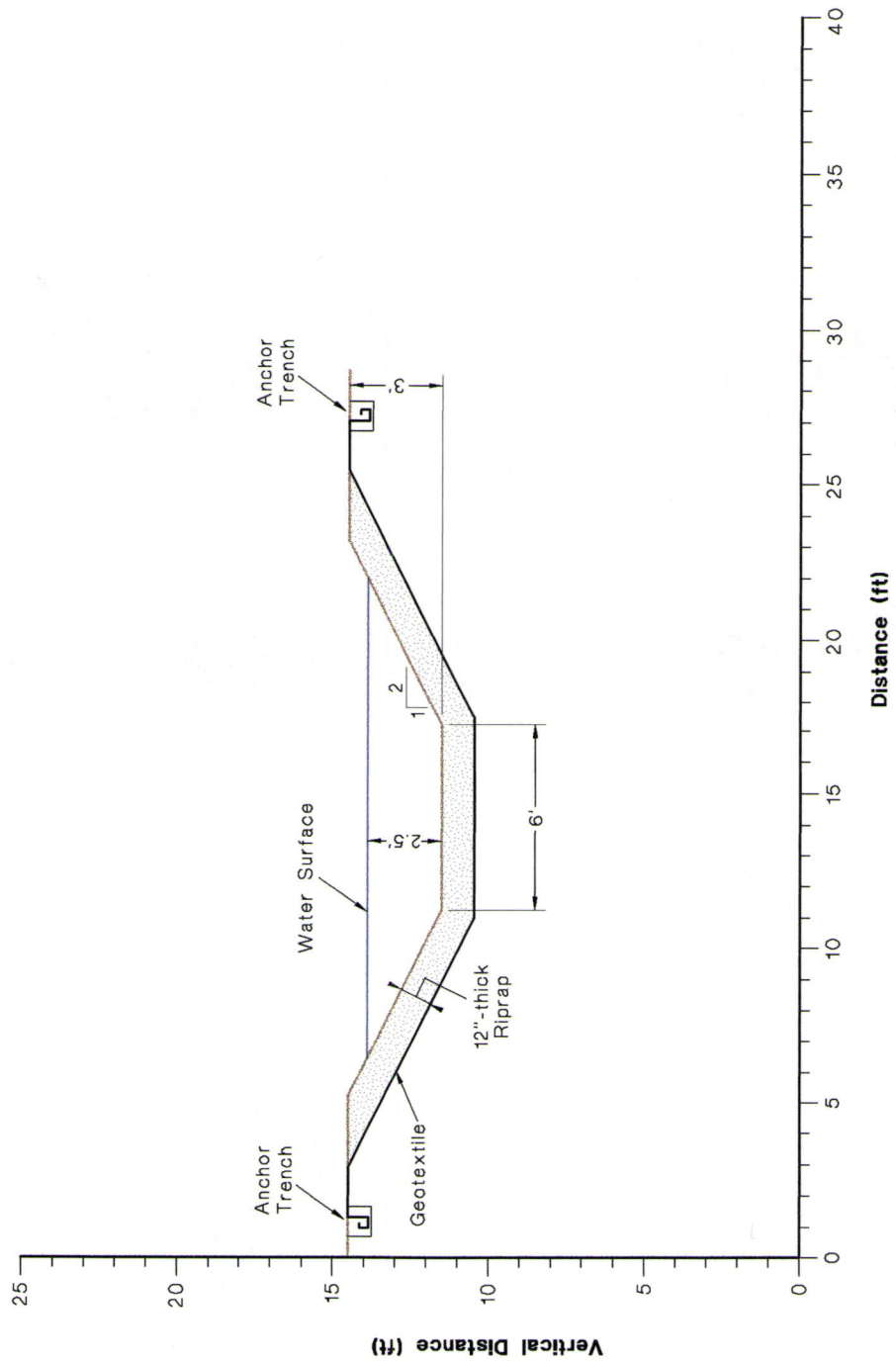


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Diversion Ditch Schematic Cross Section B-B

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Figure 4



Diversion Ditch Schematic Cross Section C-C

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Figure 5